Original Article

Trans -Ureteral Ureterolithotripsy of Ureteral Calculi: Which is the Best; Pneumatic or Holmium Laser Technique?

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Abstract:

Introduction: Our aim was to compare two types of lithotripter including holmium: YAG laser and pneumatic one in transurethral ureterolithotripsy (TUL) for the management of ureteral calculi ≥1 cm.

Methods: 112 patients with ureteral calculi more than 1 cm were selected in randomized order for pneumatic or holmium: YAG laser transurethral ureterolithotripsy (56 patients in each group). Ultrasonography and intravenous urography were performed for all patients before surgery. Complete clearance and success was defined as the absence of any fragments on post operation KUB and ultrasonography images.

Results: Success rate was 85.7% in the pneumatic group and 100% in the holmium: YAG laser group ($p = 0.003$). Stone migration up in the pelvicalyceal system was observed only in 8 cases of the pneumatic group. No statically differences were observed in terms of patients' age, hospital stay, and complications between the two groups.

Conclusion: According to our experience, for ureteral stones larger than 1 Cm treatment with ureteroscopy and laser lithotripsy is a preferring approach with favorable operation time and hospital admission, and no more significant complication.

Keywords: Complication; Success Rate; Ureter; Ureteral Calculi

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Introduction

Urinary calculi have serious implications in urology. Ureteral stones can cause obstructive uropathy and subsequent deterioration of renal function (1). Because the patient's symptoms and stone size do not predict loss of renal function, and because there is no clear time threshold for irreversible damage, intervention should be strongly considered in any patient with ureteral obstruction unless close monitoring of renal function is available (2,3).

There are five treatment options for ureteral calculi: 1) extracorporeal shockwave lithotripsy (ESWL), 2) ureteroscopic procedures, 3) percutaneous nephrolithotomy (PNL), 4) laparoscopic ureterolithotomy (LUL), and 5) open stone surgery (OSS) (2). Extracorporeal shockwave lithotripsy (SWL) (6) and rigid and flexible ureteroscopy (7) have greatly improved urologists' ability to treat ureteral calculi. However, the success rate of SWL for impacted ureteral calculi is reportedly low (8, 9). The advancement of ureteroscopy and related working instruments to manipulate or fragment ureteral calculi has significantly increased treatment options for urologists (10). For stone fragmentation, a variety of lithotripters can be used, including ultrasonic, electrohydraulic, pneumatic and laser lithotriptors.

Pneumatic lithotripsy and holmium:YAG lithotripsy have reportedly favorable outcomes (11, 12). The Swiss Lithoclast developed in Lausanne, Switzerland, fragments the stones by oscillary movements of metal probe against the stones like the jack hammer (13). The holmium: YAG laser is transmittable via flexible fibers. The thermal effect produced by holmium: YAG laser's pulses are due to formation of plasma bubbles. The bubble at the tip of the fiber connected to the holmium: YAG laser makes it possible to work on stones and soft tissues (12).

We compared available options of lithotripter including holmium: YAG laser and pneumatic transurethral ureterolithotripsy for the management of ureteral calculi ≥1 cm.

Methods

From 2007 to 2009, the patients with ureteral stones larger than 1cm presenting at our clinic, after having a negative urine culture, and matching with exclusion criteria that included uncorrectable coagulopathy, severe skeletal deformities, and failed first procedure were enrolled in the study.

We treated 112 patients having ureteral calculi in two groups using either pneumatic (56 patients) or holmium: YAG laser (56 patients) transurethral ureterolithotripsy. These patients were assigned in a randomized sequential order to a treatment using simple randomization. All patients signed informed consents for their participation in the study.

Ultrasonography and intravenous urography (IVU) were performed for all patients before surgery. Kidney, ureter, and bladder (KUB) studies, and ultrasonography were performed 4 weeks after the procedure. Complete clearance and success was defined as the absence of any fragments on post operation KUB and ultrasonography images.

Negative urine cultures were mandatory in every patient in both groups. All patients received a single shot of pre-operative antibiotic. Spinal anesthesia was employed in all patients. Ureteroscopy combined with either holmium: YAG laser or pneumatic lithotripsy was performed by a single urologist using an 8 Fr rigid ureteroscope. The patient was placed in lithotomy position. After placement of a 0.038-inch floppy tip guide wire that passed the stone, ureteroscope negotiation was performed. Continuous irrigation with ureteromate and/or intermittent manual pumping of irrigant was done to maintain a clear ureteroscopic view when appropriate. For ureteroscopic laser lithotripsy, a holmium: YAG laser which operates at a wavelength of 2100 nm was used. Frequency was usually set between 5 and 10 Hz at a power of 10 to 15 W. Swiss lithoclast with 1mm probe was used to break the stones in the other group. Stones were fragmented by using single or multiple fire technique at a single sitting. Double-J was used accordingly.

Data analyses were done with SPSS software (Statistical Package for the Social Sciences, V. 11.5; SPSS Inc, Chicago, IL, USA) using Student's *t*-test for continuous variables and the chi-square test for categorical variables. A *P* value <0.05 was considered significant.

Results

Average patients' age, the male to female ratio and stone size were similar between the groups. Success rate was 85.7% in pneumatic group and 100% in holmium: YAG laser group ($p = 0.003$). Stone migration up in the pelvicalyceal system was observed only in 8 cases of pneumatic group. Injury to ureteral wall or adjacent organs did not occur.

The mean post operation ± SD hospital stay time was 25.3 ± 0.3 and 24.4±3.2 hours in pneumatic and laser groups, respectively.

One patient (1.8%) of laser and two patients (3.6%) of pneumatic group experienced fever after surgery and was managed with conservative treatment.

Discussion

Urinary calculi have serious impacts in urology (1). The surgical options for the treatment of proximal-ureteral stones include ESWL, ureteroscopy, PNL, laparoscopic and, rarely, open surgery (2). The preferred approach for most upper-urinary stones is extracorporeal lithotripsy due to its minimal morbidity and simplicity. Ureteral calculi larger than 1 cm are more resistant to ESWL explained by the expansion-space theory (14) . Park et al. compared the results of ESWL and ureteroscopy for ureteral stones (proximal and distal) and showed though the efficacy of ESWL decreased significantly for stones larger than 1 cm (83.6% vs. 42.1%), the stone- free rate with ureteroscopic manipulation did not change by the stone size (88.9% versus 86.6%) (15).

Lithoclast lithotripsy fragments calcify with a mechanism similar to that of a pneumatic jackhammer (11). Compressed air propels a small projectile against the probe, causing the probe to oscillate back and forth at a frequency of 12 cycles per second. Fragmentation occurs as the probe tip repeatedly impacts the stone. The disadvantage of the Lithoclast was its effect of retrograde propulsion of very mobile stones or fragments in the urinary tract (16, 17). The mechanism of holmium: YAG lithotripsy is photothermal (18). Holmium: YAG energy heats the stones to a critical thermal threshold at which the stone composition is altered, yielding a stone crater and small fragments. Therefore, undesired upward migration of stone or fragments can be minimized (19). Literature shows excellent results for ureteroscopic lithotripsy using the holmium laser for proximal ureteral calculi, with a mean stone-free rate of 95% associated with a low perforation and stricture rate of about 1% (20). For this purpose, a better outcome could be achieved by flexible ureteroscopic lithotripsy as the primary approach (21). Although using the holmium laser or flexible ureteroscopic lithotripsy is expensive and not available in many centers, the use of pneumatic lithotripsy instead of holmium laser is not appropriate due to its high probability of stone migration (22).

Based upon our data, the main cause of failure in ureteroscopic lithotripsy was the migration of stone or fragments. In fact, upward migration occurred in 14.3% (8/56) of the Lithoclast group, while in none of the holmium: YAG group. The success rate of the holmium: YAG laser was excellent (100%) in our study. In terms of complications, there was no significant difference in the post-operative ureteral stricture and perforation, and uro-sepsis between two groups.

The small number of the patients and the short-term follow-up periods were the limitations of this study; therefore, we recommend comparing of the two aforesaid methods with more cases under additional assessment.

Conclusion

According to our study, holmium: YAG laser lithotripsy is a more superior technology than pneumatic lithoclast in terms of rate of stone clearance and complications. Since this is a single center study, a multi center study at a larger scale is required.

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